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Research paper

# Prevalence of depression, anxiety, and suicidal ideation during the Shanghai 2022 Lockdown: A cross-sectional study

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ABSTRACT

*Background:* Common mental disorders and suicidal ideation are associated with exposures to COVID-19 pandemic stressors, including lockdown. Limited data is available on the effect of city-wide lockdowns on population mental health. In April 2022, Shanghai entered a city-wide lockdown that sealed 24 million residents in their homes or residential compounds. The rapid initiation of the lockdown disrupted food systems, spurred economic losses, and widespread fear. The associated mental health effects of a lockdown of this magnitude are largely unknown. The purpose of this study is to estimate the prevalence of depression, anxiety, and suicidal ideation during this unprecedented lockdown.

*Methods:* In this cross-sectional study, data were obtained via purposive sampling across 16 districts in Shanghai. Online surveys were distributed between April 29 and June 1, 2022. All participants were physically present and residents of Shanghai during the lockdown. Logistic regression was used to estimate the associations between lockdown-related stressors and study outcomes, adjusting for covariates.

*Findings:* A total of 3230 Shanghai residents who personally experienced the lockdown participated the survey, with 1657 (55.5 %) men, 1563 (44.3 %) women, and 10 (0.02 %) other, and a median age of 32 (IQR 26–39), who were predominately 3242 (96.9 %) Han Chinese. The overall prevalence of depression based on PHQ-9 was 26.1 % (95 % CI, 24.8 %–27.4 %), 20.1 % (18.3 %–22.0 %) for anxiety based on GAD-7, and 3.8 % (2.9 %–4.8 %) for suicidal ideation based on ASQ. The prevalence of all outcomes was higher among younger adults, single people, lower income earners, migrants, those in poor health, and with a previous psychiatric diagnosis or suicide attempt. The odds of depression and anxiety were associated with job loss, income loss, and lockdown-related fear. Higher odds of anxiety and suicidal ideation were associated with being in close contact with a COVID-19 case. Moderate food insecurity was reported by 1731 (51.8 %), and 498 (14.6 %) reported severe food insecurity. Moderate food insecurity was associated with a >3-fold increase in the odds of screening for depression and anxiety and reporting suicidal ideation (aOR from 3.15 to 3.84); severe food insecurity was associated with >5-fold increased odds for depression, anxiety, and suicidal ideation (aOR from 5.21 to 10.87), compared to being food secure.

*Interpretation:* Lockdown stressors, including food insecurity, job and income loss, and lockdown-related fears, were associated with increased odds of mental health outcomes. COVID-19 elimination strategies including lockdowns should be balanced against the effects on population wellbeing. Strategies to avoid unneeded lockdown, and policies that can strengthen food systems and protect against economic shocks are needed.

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## 1. Introduction

Population-wide lockdowns were used throughout the COVID-19 pandemic to reduce morbidity and mortality, especially in China (Chu et al., 2020; Aknin et al., 2022). On March 28, 2022, Shanghai, the largest city in China experienced an unprecedented lockdown of the entire population of 24.9 million until June 1, 2022. A lockdown of this magnitude is unprecedented globally and provides a unique context to evaluate the relationship between lockdown related exposures and depression, anxiety, and suicidal ideation.

Government policies that aim to eradicate the virus by implementing strict containment measures are associated with increased mental health burden and lower mortality rates (Aknin et al., 2022). In Shanghai, the city-wide lockdown had unique characteristics that may be associated with population mental health, setting it apart from past lockdowns in Chinese cities and elsewhere in the world. First, it was the largest known city-wide lockdown in the world. The entire population of Shanghai was issued stay-at-home orders, and most of the gates to residential compounds in the city were sealed, restricting mobility. Second, given the rapid implementation of the lockdown and the length of the lockdown period, the city was not prepared to manage the logistic challenges. For example, during the lockdown period, residents were unable to leave their homes to purchase food in person, and few food deliveries were available. This may have led to wide-spread food insecurity, which is defined as the lack of access to sufficient, safe, and nutritious food to meet dietary needs and food preferences (FAO, 1996). Food insecurity has pernicious effects on population health and wellbeing (Pourmotabbed et al., 2020; Santos et al., 2022).

Throughout the lockdown period, Shanghai residents submitted frequent, and in some cases daily, home-based COVID-19 antigen tests coupled with nasal/oral PCR tests. This mass testing campaign across the city was utilized to detect cases of COVID-19. When cases were identified, they were taken to centralized quarantine in hotels or rapidly built hospital shelters, with limited privacy, unstable conditions, and minimum treatment availability. Close contacts of positive cases, such as roommates or neighbors, were identified as a high-risk for infection and asked to quarantine in the same facilities. This likely increased stigma toward people with COVID-19 and fear of infection (Gan et al., 2022). Shanghai residents were under constant fear that someone in their compound would test positive and they would be taken into quarantine.

As a result of the lockdown, many residents experienced either temporary or permanent unemployment and economic hardship. Those who retained their jobs also were not paid as usual, and were given reduced wages, which increased economic hardship. Economic challenges are key factors linked to mental disorders (Abdalla et al., 2021) and suicide (Qiao et al., 2022).

Previous studies have observed a high mental health burden during the COVD-19 pandemic. In one study of 1450 adults in the United States, the prevalence of anxiety was 20.5 % and this was associated with greater exposure to pandemic stressors using a composite measure (Abdalla et al., 2021). In another study of 1244 young adults (modal age 19), also in the United States, reported a prevalence of depression and anxiety was 28.0% and 20.8 % (Kreski et al., 2022).

Few studies have documented the mental health burden among populations during lockdown periods. One longitudinal study of 15 countries excluding China, demonstrated that stricter policy measures, including lockdowns, accounted for an increased burden of psychological distress (Aknin et al., 2022). Another study in Australia documented a negative change in population mental health following lockdowns, which was especially striking among women compared to men (Butterworth et al., 2022). Two studies of adults during the lockdown in Wuhan, China, at the start of the pandemic, documented an increase in anxiety symptom severity among those who were isolated due to quarantine (Gan et al., 2022; Wu et al., 2021). These studies did not estimate the prevalence anxiety in the sample, which limits our understanding of the overall patterning of mental disorders in the population. An online survey in China utilizing snowball sampling and without geographic restriction found that 25.4 % and 21.3 % of the 2331 participants experienced elevated anxiety and depressive symptoms (Guo et al., 2020).

During the 2022 Shanghai lockdown, an increase in mental health hotline service utilization was reported (Su et al., 2022), along with an increase in searches for depression on the Chinese internet search engine Baidu (Zhou et al., 2023). Although these indirect sources suggest an increase in mental health burden occurred, studies are needed to estimate the population prevalence of mental disorders during the 2022 Shanghai lockdown.

The current study is the first and only known study to document the mental health burden associated with the 2022 Shanghai city-wide lockdown. This lockdown is unique compared to studies conducted in 2020 at the start of the pandemic (Gan et al., 2022; Guo et al., 2020). In the year leading up to the lockdown, people in Shanghai experienced low exposure to COVID-19 and few disruptions to life compared to the rest of the world due to China's COVID-19 control policies. The sudden and unexpected lockdown took place while most of the world had reduced or eliminated stringent COVID-19 controls. This study contributes to our knowledge about lockdown mental health by estimating the prevalence of mental disorders in a population exposed to lockdowns years after the pandemic began. In addition, it estimates the prevalence among several key populations, often understudied, including migrant workers, and measures key correlates and exposures unique to this lockdown period (e.g., food insecurity), which provides actionable information for future public health planning and response. In addition, few studies estimated suicidal ideation, leaving a key gap in the literature regarding a critical mental health issue.

To understand the impact of this unprecedented lockdown on population mental health, the current study had the following aims: 1) Estimate the burden of depression, anxiety, and suicidal ideation among Chinese residents living in Shanghai during the lockdown, 2) evaluate the association between population demographics and mental health outcomes, 3) clarify the role of consequences of the lockdown, including economic losses and food insecurity on population mental health.

## 2. Methods

### 2.1. Participant recruitment and eligibility

The 2022 Shanghai Lockdown Study recruited participants via purposive sampling to reach a geographic target sample of 200 residents in each of the 16 districts in Shanghai, with 10 % oversampling in case of invalid responses. Questionnaires were distributed online in Chinese through the Wenjuan Xing platform, the most widely used data collection platform in China (Ranxing Information Technology Co., LTD., n. d.), between April 29 and June 1, 2022 (from the middle to the end of the of the lockdown period). Only Chinese adults over 18 were eligible. Network IP addresses were used to identify potential participants who were residents in Shanghai during the lockdown period. Digital informed consent was obtained before study participation. An incentive of 6 Chinese Yuan (~$1USD) was provided to those who completed the survey. The study was approved by the NYU Shanghai Institutional Review Board.

### 2.2. Measures and instruments

#### 2.2.1. Study outcomes

Depression and anxiety were assessed with the validated Chinese versions of the nine-item Patient Health Questionnaire (PHQ-9) (Yeung et al., 2008), and the seven-item Generalized Anxiety Disorder Scale (GAD-7). Each scale assessed symptom severity occurring over the last two weeks on a 4-point scale (not at all, several days, more than half the days, nearly every day). Internal reliability was excellent for both scales (Cronbach's = 0.89 for PHQ-9; Cronbach's = 0.92 for GAD-7). Total

scores for each scale were dichotomized using the standard applied cut score of 10 or higher. Suicidal ideation was assessed by combining two yes/no items from the Ask Suicide-Screening Questions (Horowitz et al., 2020) (ASQ), which queried 1) if they thought they would be better off dead than to be in lockdown and 2) if they had considered ending their life during the lockdown.

#### 2.2.2. Choice of primary measures

The PHQ-9 and GAD-7 are the widest used and freely available scales (translated into numerous languages) to assess depression and anxiety globally in psychiatric epidemiological studies and have been validated and used extensively in Chinese populations. A score of 10 or higher is commonly applied as a clinical threshold for the PHQ-9, although recent meta-analytic studies demonstrated that this score may not align with a clinical diagnosis and may yield higher prevalence estimates than structured interviews (Levis et al., 2019). The suicidal ideation indicator was chosen from the ASQ, which was validated as a suicide screening tool in large population surveys, and sensitive to thoughts and desires for suicide.

#### 2.2.3. Lockdown-related stressor exposures

Several key COVID-19- and lockdown-related stressor exposures were assessed. First, we assessed *COVID-19 stressors*, including the history of quarantine during the lockdown, current or previous COVID-19 infection, and being in close contact with someone infected with COVID-19. Second, we assessed two *lockdown-related economic stressor* exposures, including temporary or permanent loss of employment and the percentage of income lost (none, <50 %, or >50 %). Third, *Household Food Insecurity* was measured using five items adapted from the Household Food Insecurity Access Scale (HFIAS) (Coates et al., 2007). The items assessed three domains of food insecurity: anxiety and uncertainty about household food supply, insufficient quality and variety of available food, and insufficient food intake. Items assessed whether the event occurred and the frequency of occurrences of each item based on experiences since the lockdown began, and over the past two weeks, on a three-point Likert-type scale from 0 "rarely" 1 "sometimes" to 2 "Often." Households were categorized into food secure, mildly insecure, moderately insecure, and severely food insecure based on the endorsement of frequent and more severe experiences, following standard scoring (Coates et al., 2007). The HFIAS has demonstrated validity in diverse countries and populations (Mohammadi et al., 2012), and has previously been used in China (Zhang et al., 2021). Finally, an index of five items assessed *lockdown-related fears*, on a 5-point scale with responses ranging from 0 "not at all" to 4 "extremely." Individual items assessed fears of a family member being infected, being sent to quarantine, becoming seriously ill due to COVID-19 infection, not being able to pay rent or mortgage, and remaining in lockdown. Items were summed and trichotomized into roughly equal thirds to indicate low, medium, and high levels of lockdown-related fears.

#### 2.2.4. Study covariates

Study covariates included gender (male, female, other), age group (18–24, 25–34, 35–44, 45–54, ≥55), ethnicity (Han Chinese vs. other), educational attainment (Secondary or lower, High school, College or higher), marital status (Single, Married/cohabitating, Divorced/widowed), household income (<4000, 4001 to 8000, 8001 to 15,000, 15,001 to 30,000, 30,000 or higher), employment status (Employed, Unemployed, Retired, Student), migration status (Shanghai local, Migrant with hukou, Migrant without hukou, Temporary), whether they are staying in their habitual residence (no/yes), their household size, self-reported general health (dichotomized as excellent/very good/good vs. fair/poor), previous psychiatric diagnosis by a mental health professional (no/yes), and past history of suicide attempt (no/yes).

### 2.3. Statistical analysis

All analyses incorporated survey weights to adjust for deviations between the sample and the most recent Shanghai census. Weights were calculated by utilizing logistic regression models to create an inverse probability of sampling weights to account for the differences in the distribution of covariates (i.e., district and age) between the study population and the 2020 Shanghai Census data (Cole and Stuart, 2010). We then applied these weights to the study population so that the estimates would better represent the total Shanghai population.

We estimated the prevalence of depression, anxiety, and suicidal ideation. Study covariates were described using raw frequencies and weighted percentages, and bivariable associations between study covariates were assessed with two-tailed $\chi^2$ tests. A series of binary logistic regression analyses were conducted to estimate the unadjusted association between each COVID-19- and lockdown-related stressor exposure and each mental health indicator. These models were then estimated by adjusting for all study covariates along with residential district and at date of study completion, to account for potential confounding by location and lockdown period. Analyses were conducted using *svy* commands in Stata/MP 14.2, with statistical significance at $p < .05$. The 95 % confidence intervals (CI) for the prevalence and odds ratios were calculated. The study analysis followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines (von Elm et al., 2007).

## 3. Results

### 3.1. Sample demographics

Overall, 3763 people responded to the invitation to participate in the study. A final analytic sample contained 3230 Shanghai residents after removal of minors ($n$ = 156), people not currently in Shanghai ($n$ = 190), possible duplicate entries ($n$ = 118) and those who responded inappropriately to survey validity questions ($n$ = 69). The median duration of survey completion was 15.7 min (IQR: 12.5–21.7).

The sample characteristics and bivariable associations with main study outcomes are presented in Table 1. The majority of the weighted sample was aged 25–34 years (1346/36.8 %) (*MedianAge* 32, *IQR 26–39*, *range* 18–88), male (1657/55.3 %), Han Chinese (3126/96.9 %), a university graduate (2045/62.7 %), married/cohabitating (2032/68.9 %), with an income between 8000 and 15,000 Chinese Yuan (996/32.8 %). Roughly half were migrants without a Shanghai household registration (i.e., *hukou*) (1790/49.9 %). Previous psychiatric diagnosis was reported by 146 (3.8 %), and 58 (1.4 %) people reported a previous suicide attempt.

454 (12.0 %) of the sample had a previous quarantine experience, and 147 (3.7 %) of the sample had a history of COVID-19 infection, with 139 (3.7 %) reporting current infection, and 320 (9.0 %) were close contacts. One in 5 people (722) reported a job loss due to the lockdown, with 245/722 (6.8 %) being permanently out of work. The majority (2504/69.2 %) reported loss to income, with 1108 (30.7 %) reporting losing of over 50 % of their salary during the lockdown period. Food insecurity (FI) was common, with 476 (16.4 %) being mild FI, 1731 (51.8 %) being moderate FI, and 498 (14.6 %) being severely FI; just 517 (17.2 %) of the sample were food secure.

### 3.2. Prevalence estimates

Among the 3230 participants, 903 (26.1 %, 95 % CI, 24.8 %–27.4 %) met screening threshold for depression, 695 (20.1 %, 18.3 %–22.0 %) for anxiety, and 145 (3.8 %, 2.9 %–4.8 %) reported suicidal ideation. Those who were single had a higher prevalence of depression and anxiety, while the highest prevalence of suicidal ideation was among divorced/widowed. People who were unemployed and who were students had the highest prevalence of each outcome. The highest prevalence of suicidal

**Table 1**
Participant characteristics of Shanghai residents during the 2022 Lockdown and bivariable associations with depression, anxiety, and suicidal ideation ($N = 3230$).

| | | Depression | | *p* | Anxiety | | *p* | Suicidal ideation | | *p* |
|---|---|---|---|---|---|---|---|---|---|---|
| | N (%) | No | Yes | | No | Yes | | No | Yes | |
| Overall | 3230 (100) | 2327 (73.9) | 903 (26.1) | n/a | 2535 (79.9) | 695 (20.0) | n/a | 3085 (96.2) | 145 (3.8) | n/a |
| Sex | | | | .30 | | | .07 | | | .22 |
| Male | 1657 (55.4) | 1210 (74.9) | 447 (25.1) | | 1327 (81.4) | 330 (18.6) | | 1594 (97.0) | 63 (3.0) | |
| Female | 1563 (44.4) | 1112 (72.9) | 451 (27.1) | | 1202 (78.1) | 361 (22.0) | | 1482 (95.4) | 81 (4.7) | |
| Other | 10 (0.03) | 5 (36.3) | 5 (63.7) | | 6 (71.1) | 4 (28.8) | | (93.3) | 1 (6.7) | |
| Age | | | | <.0001 | | | .040 | | | .040 |
| 18–24 | 671 (16.1) | 418 (61.5) | 253 (38.5) | | 486 (72.3) | 185 (27.8) | | 611 (92.0) | 60 (8.1) | |
| 25–34 | 1346 (37.0) | 945 (70.6) | 401 (29.5) | | 1035 (76.4) | 312 (23.6) | | 1288 (96.2) | 58 (3.8) | |
| 35–44 | 703 (18.9) | 548 (76.2) | 155 (23.8) | | 571 (80.1) | 132 (19.2) | | 688 (97.1) | 15 (3.0) | |
| 45–54 | 354 (9.7) | 282 (81.3) | 72 (18.8) | | 306 (87.3) | 48 (12.6) | | 344 (98.1) | 10 (1.9) | |
| ≥55 | 156 (18.3) | 134 (85.5) | 22 (14.6) | | 138 (88.9) | 18 (10.1) | | 154 (98.4) | 2 (1.7) | |
| Ethnicity | | | | .58 | | | .69 | | | .47 |
| Han | 3126 (96.9) | 2249 (73.8) | 877 (26.2) | | 2457 (80.0) | 669 (20.0) | | 2985 (96.3) | 141 (3.7) | |
| Other | 104 (3.1) | 78 (77.4) | 26 (22.6) | | 78 (77.9) | 26 (22.1) | | 100 (94.0) | 4 (6.0) | |
| Education | | | | .33 | | | .42 | | | .48 |
| Secondary/lower | 471 (14.7) | 338 (74.9) | 133 (25.1) | | 377 (81.6) | 94 (184) | | 443 (95.1) | 28 (4.9) | |
| High school | 714 (22.5) | 522 (76.0) | 192 (24.0) | | 574 (82.0) | 140 (18.0) | | 681 (96.4) | 33 (3.6) | |
| College/higher | 2045 (62.7) | 1467 (72.9) | 578 (27.1) | | 1584 (78.4) | 461 (21.3) | | 1961 (96.5) | 84 (3.5) | |
| Marital status | | | | <.0001 | | | .02 | | | .012 |
| Single | 1079 (27.3) | 714 (66.0) | 365 (34.0) | | 812 (75.2) | 267 (24.8) | | 1009 (94.4) | 70 (5.6) | |
| Married/cohabitating | 2032 (68.8) | 1523 (77.0) | 509 (23.0) | | 1628 (81.5) | 404 (18.5) | | 1965 (97.2) | 67 (2.8) | |
| Divorced/widowed | 119 (3.8) | 90 (79.4) | 29 (20.6) | | 95 (83.8) | 24 (16.2) | | 111 (92.3) | 8 (7.7) | |
| Household income | | | | .007 | | | .07 | | | .06 |
| Less than 4000 | 351 (8.7) | 228 (63.5) | 123 (36.4) | | 259 (74.0) | 92 (26.0) | | 324 (92.1) | 27 (7.9) | |
| 4001 to 8000 | 904 (31.4) | 648 (73.7) | 256 (26.3) | | 724 (81.9) | 180 (18.1) | | 869 (97.0) | 35 (3.0) | |
| 8001 to 15,000 | 996 (32.8) | 722 (76.8) | 274 (23.2) | | 787 (81.2) | 209 (18.8) | | 954 (96.7) | 42 (3.3) | |
| 15,001 to 30,000 | 685 (19.1) | 513 (73.9) | 172 (26.2) | | 539 (77.7) | 146 (22.3) | | 659(96.2) | 26 (3.8) | |
| 30,000 or higher | 294 (8.1) | 216 (74.6) | 78 (25.4) | | 226 (78.9) | 68 (21.2) | | 279 (96.0) | 15 (4.0) | |
| Employment | | | | .001 | | | .02 | | | <.0001 |
| Employed | 2430 (67.2) | 1817 (73.3) | 613(26.7) | | 1965 (81.1) | 465 (18.9) | | 2352 (96.9) | 78 (3.1) | |
| Unemployed | 369 (10.5) | 207 (59.0) | 162 (41.0) | | 244 (65.9) | 125 (34.1) | | 338 (91.7) | 31 (8.3) | |
| Retired | 101 (15.4) | 90 (91.8) | 11 (8.2) | | 89 (88.6) | 12 (11.3) | | 99 (99.2) | 2 (0.08) | |
| Student | 328 (6.9) | 211 (62.5) | 117 (37.5) | | 236 (70.1) | 92 (29.9) | | 294 (90.0) | 34 (10.0) | |
| Migrant status | | | | .0003 | | | .003 | | | .37 |
| Shanghai local | 1004 (38.2) | 793 (81.6) | 211 (18.4) | | 837 (86.8) | 167 (13.2) | | 954 (97.0) | 50 (3.0) | |
| Migrant with hukou | 436 (11.9) | 309 (71.5) | 127 (28.5) | | 341 (77.8) | 95 (22.2) | | 419 (96.8) | 17 (3.2) | |
| Migrant, no hukou | 929 (25.0) | 670 (70.3) | 259 (29.7) | | 719 (76.5) | 210 (23.6) | | 888 (95.3) | 41 (4.7) | |
| Temporary | 861 (24.9) | 555 (66.9) | 306 (33.1) | | 638 (73.8) | 223 (26.2) | | 824 (95.8) | 37 (4.2) | |
| Habitual residence (yes) | | | | .13 | | | .88 | | | .14 |
| No | 523 (84.2) | 370 (74.6) | 153 (25.4) | | 409 (79.8) | 114 (20.2) | | 491 (96.5) | 32 (3.5) | |
| Yes | 2707 (15.7) | 1957 (70.2) | 750 (29.8) | | 2126 (80.3) | 581 (19.7) | | 2594 (94.9) | 113 (5.1) | |
| Household size | | | | .11 | | | .10 | | | .22 |
| Live alone | 330 (96.6) | 231 (63.5) | 99 (36.5) | | 258 (79.5) | 72 (20.5) | | 320 (96.6) | 10 (3.4) | |
| 2 people | 786 (27.8) | 543 (74.7) | 243 (25.3) | | 615 (81.3) | 171 (18.7) | | 749 (97.1) | 37 (2.9) | |
| 3 people | 1101 (32.5) | 832 (77.4) | 269 (22.7) | | 895 (2.8) | 206 (17.3) | | 1063 (97.1) | 38 (2.9) | |
| 4 people | 514 (13.9) | 368 (71.7) | 146 (28.3) | | 390 (75.8) | 124 (24.4) | | 478 (93.5) | 36 (6.6) | |
| 5 or more people | 499 (16.1) | 353 (73.7) | 146 (26.3) | | 377 (75.8) | 122 (24.3) | | 475 (95.3) | 24 (4.7) | |
| Self-rated health | | | | <.0001 | | | <.0001 | | | <.0001 |
| Excellent/very good/good | 2964 (92.0) | 2240 (77.4) | 724 (22.6) | | 2423 (83.3) | 541 (16.7) | | 2861 (97.3) | 103 (2.7) | |
| Fair or poor | 266 (8.0) | 87 (33.4) | 179 (66.6) | | 112 (40.8) | 154 (59.2) | | 224 (83.8) | 42 (16.2) | |
| Past psychiatric diagnosis | | | | <.0001 | | | <.0001 | | | <.0001 |
| No | 3084 (96.2) | 2267 (75.1) | 817 (24.9) | | 2464 (81.1) | 620 (18.9) | | 2973 (97.0) | 111 (3.0) | |
| Yes | 146 (3.8) | 60 (44.0) | 86 (56.0) | | 71 (48.6) | 75 (51.4) | | 112 (77.0) | 34 (23.0) | |
| Past suicide attempt | | | | <.0001 | | | <.0001 | | | <.0001 |
| No | 3172 (98.6) | 2307 (74.5) | 865 (25.5) | | 2513 (80.5) | 659 (19.5) | | 3064 (97.1) | 108 (2.9) | |
| Yes | 58 (1.4) | 20 (30.0) | 38 (70.0) | | 22 (36.7) | 36 (63.2) | | 21 (34.4) | 37 (65.6) | |

*Note*. Data shown are raw numbers and weighted percentages as *N* (%).

ideation among sub-populations was 10.0 % and was reported among students. All migrant groups had a higher prevalence of depression and anxiety than local Shanghai-born residents. Self-rated health, previous history of mental health diagnosis, and past suicide attempts were each associated with a higher prevalence of all study outcomes (See Table 2).

### 3.3. Bivariable associations between COVID-19 and lockdown-related stressors

The prevalence of all mental health outcomes was significantly higher among those with a history of quarantine during this lockdown, with a history of COVID-19 infection, being considered a close contact, losing their job due to lockdown, greater loss of income, food insecurity, and greater lockdown-related fears. People with severe levels of food insecurity had the highest prevalence of depression (45.9 %), anxiety (41.1 %), and suicidal ideation (9.3 %) among study exposures (prevalence differences between severe food insecurity and all other exposures aside from history of COVID infection, were higher, with ranges from 4.5 %–13.7 % for depression, 3.2 %–19.1 % for anxiety, and 0.3 %–6.1 % for suicidal ideation).

### 3.4. Multivariable regression models

Table 3 reports the results of adjusted binary logistic regression

**Table 2**
Association between lockdown and COVID-19 stressors on depression, anxiety, and suicidal ideation ($N = 3348$).

| | N | Depression | | *p* | Anxiety | | *p* | Suicidal ideation | | *p* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No | Yes | | No | Yes | | No | Yes | |
| Quarantine history | | | | .02 | | | .002 | | | .02 |
| No | 2776 (88.0) | 2011 (74.8) | 765 (25.2) | | 2206 (81.2) | 570 (18.9) | | 2667 (96.7) | 109 (3.3) | |
| Yes | 454 (12.0) | 316 (67.8) | 138 (32.2) | | 329 (70.8) | 125 (29.2) | | 418 (92.9) | 36 (7.1) | |
| COVID infection | | | | .05 | | | .16 | | | <.0001 |
| No | 3073 (96.0) | 2223 (74.3) | 850 (25.7) | | 2420 (80.2) | 653 (19.8) | | 2946 (96.5) | 127 (3.5) | |
| During this outbreak | 139 (3.7) | 96 (67.2) | 43 (32.8) | | 105 (73.4) | 34 (26.6) | | 126 (90.0) | 13 (10.0) | |
| Before March 2022 | 18 (0.03) | 8 (43.0) | 10 (57.0) | | 10 (55.5) | 8 (44.5) | | 13 (74.2) | 5 (25.8) | |
| Close contact | | | | .001 | | | <.0001 | | | .007 |
| No | 2910 (91.0) | 2121 (75.0) | 789 (5.0) | | 2313 (81.2) | 597 (18.8) | | 2793 (96.7) | 117 (3.3) | |
| Yes | 320 (9.0) | 206 (62.5) | 114 (37.5) | | 222 (66.9) | 98 (33.1) | | 292 (91.9) | 28 (8.1) | |
| Lost job due to lockdown | | | | <.0001 | | | <.0001 | | | <.0001 |
| No | 2508 (80.3) | 1903 (77.5) | 605 (22.5) | | 2043 (83.0) | 465 (17.0) | | 2418 (97.5) | 90 (2.5) | |
| Temporary loss | 477 (12.9) | 280 (59.8) | 197 (40.2) | | 334 (70.0) | 143 (30.0) | | 441 (91.4) | 36 (8.6) | |
| Permanent loss | 245 (6.8) | 144 (58.7) | 101 (41.4) | | 158 (62.1) | 87 (37.9) | | 226 (91.0) | 19 (9.0) | |
| Percentage of income lost | | | | <.0001 | | | <.0001 | | | .012 |
| None | 729 (30.7) | 603 (86.9) | 126 (13.1) | | 635 (89.8) | 94 (10.2) | | 703 (98.5) | 26 (1.5) | |
| Less than 50 % | 1393 (38.6) | 1014 (70.0) | 379 (29.7) | | 1090 (76.9) | 303 (23.1) | | 1332 (95.6) | 61 (4.4) | |
| More than 50 % | 1108 (30.7) | 710 (65.4) | 398 (34.6) | | 810 (73.8) | 298 (26.2) | | 1050 (94.7) | 58 (5.3) | |
| Food insecurity (FI) | | | | <.0001 | | | <.0001 | | | <.0001 |
| Food secure | 517 (17.2) | 444 (88.9) | 73 (11.1) | | 475 (94.0) | 42 (6.0) | | 500 (98.5) | 17 (1.5) | |
| Mild FI | 476 (16.4) | 414 (89.6) | 62 (10.4) | | 429 (91.7) | 47 (8.3) | | 466 (98.7) | 10 (1.3) | |
| Moderate FI | 1731 (51.8) | 1202 (69.5) | 529 (30.5) | | 1314 (77.3) | 417 (22.7) | | 1559 (96.2) | 73 (3.8) | |
| Severe FI | 498 (14.6) | 260 (54.1) | 238 (45.9) | | 310 (58.9) | 188 (41.1) | | 452 (90.8) | 46 (9.3) | |
| Lockdown-related fears | | | | <.0001 | | | <.0001 | | | .064 |
| Low | 1129 (37.6) | 902 (83.9) | 227 (16.1) | | 978 (88.6) | 151 (11.4) | | 1082 (96.9) | 47 (3.1) | |
| Moderate | 1095 (34.5) | 799 (71.5) | 296 (28.5) | | 853 (78.0) | 242 (22.0) | | 1050 (96.8) | 45 (3.2) | |
| High | 1006 (27.9) | 626 (63.5) | 380 (36.5) | | 704 (70.5) | 302 (29.5) | | 953 (94.6) | 53 (5.4) | |

**Table 3**
Associations between lockdown stressors and COVID-19 stressors on depression, anxiety, and suicidal ideation (N = 3348).

| | Depression | | Anxiety | | Suicidal ideation | |
|---|---|---|---|---|---|---|
| | Model 1 OR (95 % CI) | Model 2 aOR (95 % CI) | Model 1 OR (95 % CI) | Model 2 aOR (95 % CI) | Model 1 OR (95 % CI) | Model 2 aOR (95 % CI) |
| Quarantine history | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | **1.41 (1.06–1.88)** | 1.06 (0.78–1.44) | **1.78 (1.26–2.50)** | 1.42 (0.99–2.04) | **2.22 (1.06–4.47)** | 1.68 (0.84–3.38) |
| COVID infection | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| During this outbreak | 1.40 (0.84–2.37) | 0.77 (0.46–1.30) | 1.47 (0.73–2.96) | 0.79 (0.42–1.49) | **3.09 (1.57–6.05)** | 1.78 (0.85–3.71) |
| Before March 2022 | **3.82 (1.34–10.87)** | 2.31 (0.73–7.33) | **3.25 (0.85–12.41)** | 1.77 (0.41–7.62) | **9.67 (4.07–22.99)** | **8.84 (1.63–20.98)** |
| Close contact | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | **1.80 (1.30–2.50)** | 1.42 (0.91–2.20) | **2.14 (1.60–2.86)** | **1.74 (1.25–2.42)** | **2.57 (1.32–5.02)** | **1.99 (1.12–3.53)** |
| Lost job due to lockdown | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Temporary loss | **2.31 (1.79–2.99)** | **1.90 (1.49–2.43)** | **2.10 (1.62–2.71)** | **1.75 (1.31–2.32)** | **3.60 (2.18–5.96)** | **3.35 (1.35–8.32)** |
| Permanent loss | **2.43 (1.92–3.06)** | **2.11 (1.75–2.55)** | **2.98 (2.40–3.70)** | **2.78 (2.27–3.42)** | **3.82 (1.85–7.88)** | **2.52 (1.08–5.86)** |
| Percentage of income lost | | | | | | |
| None | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Less than 50 % | **2.80 (1.89–4.15)** | **2.93 (1.85–4.64)** | **2.63 (1.74–3.98)** | **2.54 (1.33–4.84)** | **2.92 (1.13–7.55)** | 2.52 (0.71–8.93) |
| More than 50 % | **3.50 (2.59–4.75)** | **3.71 (2.58–5.33)** | **3.11 (2.19–4.42)** | **2.94 (1.79–4.81)** | **3.56 (1.50–8.47)** | 2.09 (0.71–6.17) |
| Food insecurity (FI) | | | | | | |
| Food secure | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Mild FI | 0.93 (0.56–1.56) | 1.03 (0.58–1.82) | 1.40 (0.83–2.39) | 1.43 (0.81–2.56) | 0.85 (0.28–2.58) | 1.36 (0.34–5.50) |
| Moderate FI | **3.52 (2.38–5.20)** | **3.15 (2. 10–4.73)** | **4.57 (3.48–6.00)** | **3.84 (2.60–5.65)** | **2.62 (1.11–6.16)** | **3.14 (1.12–8.80)** |
| Severe FI | **6.80 (5.43–8.52)** | **4.83 (3.57–6.55)** | **10.87 (7.21–16.37)** | **7.52 (3.84–14.72)** | **6.78 (2.66–17.29)** | **5.21 (2.06–13.16)** |
| Lockdown-related fears | | | | | | |
| Low | 1.00 | 1.00 | | | 1.00 | 1.00 |
| Moderate | **2.08 (1.37–3.13)** | **2.03 (1.44–2.88)** | **2.19 (1.34–3.56)** | **2.14 (1.39–3.30)** | 1.02 (0.60–1.76) | 0.94 (0.42–2.14) |
| High | **2.99 (1.84–4.86)** | **2.68 (1.69–4.25)** | **3.24 (2.23–4.70)** | **2.77 (1.71–4.50)** | 1.79 (0.93–3.42) | 1.38 (0.58–3.24) |

*Note.* OR = odds ratio which is the unadjusted association between the exposure and outcome. aOR = adjusted odds ratio, which is the association between the exposure and outcome adjusted by covariates and residential district and study period. Bold estimates are $p < .05$.

analysis. Job loss (temporary loss (aOR = 1.90, 95 % CI 1.49–2.43) or permanent loss (aOR = 2.11, 95 % CI 1.75–2.55)) compared to stable employment was associated with increased odds of depression. Percentage of income lost was also associated with higher odds of depression (<50 % (aOR = 2.93, 95 % CI 1.85–4.64), and >50 % (aOR = 3.71, 95 % CI 2.58–5.33) compared to no loss to income. Moderate (aOR = 3.15, 95 % CI 2.10–4.73) and severe (aOR = 4.83, 95 % CI 3.57–6.55) FI, were associated with greater odds of depression compared to being food secure. Finally, moderate (aOR = 2.03, 95 % CI 1.44–2.88) and high (aOR = 2.68, 95 % CI 1.69–4.25) lockdown-related fears, compared

with low fear was associated with higher odds of depression.

For anxiety, being a close contact (versus not) was also associated with greater odds of anxiety (aOR = 1.74, 95 % CI 1.25–2.42). Job loss (temporary loss (aOR = 1.75, 95 % CI 1.31–2.32) or permanent loss (aOR = 2.78, 95 % CI 2.27–3.42)) compared to stable employment was associated with increased odds of anxiety. Percentage of income lost was also associated with higher odds of anxiety (<50 % (aOR = 2.54, 95 % CI 1.33–4.84), and >50 % (aOR = 2.94, 95 % CI 1.79–4.81)) compared to no loss to income. Moderate (aOR = 3.84, 95 % CI 2.60–5.65) and severe (aOR = 7.52, 95 % CI 3.84–14.72) FI, were associated with greater odds of anxiety compared to being food secure. Finally, medium (aOR = 2.14, 95 % CI 1.39–3.30) and high (aOR = 2.77, 95 % CI 1.71–4.50) lockdown-related fears, compared with low fear was associated with higher odds of anxiety.

For suicidal ideation, previous COVID infection (vs. no) was associated with greater odds of suicidal ideation (aOR = 8.84, 95 % CI 1.63–20.98), as was being a close contact (versus not) (aOR = 1.99, 95 % CI 1.12–3.53). Job loss (temporary loss, (aOR = 3.35, 95 % CI 1.35–8.32) or permanent loss (aOR = 2.52, 95 % CI 1.08–5.86)) compared to stable employment was associated with increased odds of suicidal ideation. Moderate (aOR = 3.14, 95 % CI 1.12–8.80) and severe (aOR = 5.21, 95 % CI 2.06–13.16) FI was associated with greater odds of suicidal ideation.

## 4. Discussion

The current study of adult Chinese Shanghai residents was conducted during the height of the unprecedented lockdown. A high mental health burden was observed, with 26.1 % of the total population meeting screening thresholds for depression, 20.1 % for anxiety, and 3.8 % reporting suicidal ideation. These estimates demonstrate a high burden of mental ill health among Shanghai residents and are considerably higher when compared with pre-pandemic and previous lockdown psychiatric epidemiological studies (Li et al., 2019; Zhao et al., 2019; Zhao et al., 2022; Lee et al., 2007). For example, epidemiological studies conducted before the pandemic, using the same scale and cutoff as the current study, show the prevalence of depression among Shanghai adult residents was 12.8 % to 17.3% (Li et al., 2019; Zhao et al., 2019), and with a prevalence of anxiety of 8.5 % (Zhao et al., 2022). Regarding suicidal ideation, the current prevalence is higher than lifetime prevalence of suicide ideation among residents in Shanghai and Beijing (3.1 %) (Lee et al., 2007). Overall, these estimates are higher than those obtained within the general population, with anxiety and depression estimated as 7.6 % and 6.8 %, respectively (Huang et al., 2019).

Further, Shanghai's reported mental health burden is higher than estimates from lockdown studies from countries with even higher cases and mortality rates. The prevalence of depression and anxiety symptoms was 23.8 % and 17.2 % in the middle of the strict lockdown starting in March 2020 in the UK (Fancourt et al., 2021). In Australia, the prevalence of depression, anxiety, and suicidal intention was 14.4 %, 12.2 %, and 2.2 %, respectively, 5 to 8 weeks after the government announced a nationwide lockdown, which is similar to the timeframe of our current study (Staples et al., 2020).

### 4.1. The association between lockdown-related stressor exposures and mental health

Over 65.0% of the residents reported moderate or severe food insecurity, which was higher than the first COVID-19 lockdown in Wuhan (51.6 %) (Zhang et al., 2021). The residents of Shanghai who experienced food insecurity were exposed to this due to the city-wide lockdown and not necessarily due to long-standing issues with food security. The pre-COVID-19 pandemic percentage of moderate to severe household food insecurity in similar big cities in China was 7.4 % (Si Z ZT, 2018). The current figure in Shanghai is nearly nine times higher. Food insecurity emerged as a key correlate of mental ill health in the sample. This study was consistent with other studies during the COVID-19 pandemic, which demonstrated an association between food insecurity and mental health (Wolfson et al., 2021). The current study provides additional evidence in support of lessons learned during the first Wuhan lockdown of the need to ensure a sustainable food supply to residents, mobilize grass-roots committees, and ensure greater logistical support in the city. Ensuring strong food systems within the context of the ongoing COVID-19 pandemic is a key concern (Zhang et al., 2021).

Throughout the lockdown period, people who were infected with COVID-19 or were close contacts were taken to quarantine facilities, either hotels or centralized hospital-based quarantine, which may not be private and may be associated with possible infection for those who were close contacts. Determinations of being a close contact were non-transparent. In the current study, this may account for why being a close contact, but not having a COVID-19 infection was associated with greater anxiety, but not depression. The fear of quarantine and the lack of controllability in being a close contact appears to partially account for the development of anxiety and suicidal ideation in this sample.

Consistent with previous studies (Ettman et al., 2022; Elbogen et al., 2021), the economic consequences of the lockdown were associated with poor mental health. People who lost their jobs and those who experienced reduced income reported greater mental health problems. This directly calls for strategies that avoid unnecessary lockdowns and when needed, reduce lockdown periods. Policy considerations should include the economic impact of COVID-19 controls, as these effects are likely to result in greater longer-term burdens for the entire economy, which may further exacerbate mental-ill health.

### 4.2. Key demographic groups and mental health

Young adults, including students, reported the highest burden of mental-ill health in the sample, which is supported by a global trend observed during the pandemic. Meta-analytic results of global pooled prevalence estimate (Deng et al., 2021) showed 28.0% for depression and 32.0% for anxiety. The current sample reported comparatively higher rates of depression but slightly lower rates of anxiety. These populations need targeted psychosocial intervention during lockdown periods.

Shanghai is home to a large number of migrants, who are known to have complex relationships between migration status and vulnerability to mental disorders across the life course (Chen et al., 2022). In the present study, we disaggregated migrant status from household registration status (i.e., *Hukou* status) in order to make more granular subgroup comparisons. Compared to Shanghai locals, migrants experienced a higher burden of mental health, regardless if they converted their *hukou* to Shanghai. The estimated prevalence of depression in the current study was 10 % higher than the previous large study of diverse migrant workers in Shanghai (Wang et al., 2019). Vulnerability among migrants in this study may be due to fewer social ties, belongingness, lack of access to food, and economic inequalities that systemically differ between groups (Li et al., 2019).

### 4.3. Limitations

There are several limitations of the current study. First, face-to-face interviews were infeasible, and self-report screening tools may not comport with clinician interviews. Comparisons with studies using similar screening methods are indicated. Second, the majority of the sample were young and educated, which indicates potential for selection bias and may not fully generalize to the entire Shanghai population. However, we adjusted for survey response bias by weighting the sample by district and age and conducted stratified purposive sampling by districts to improve the sample representativeness. Third, the study is cross-sectional in design which limits causal inference. Fourth, we could not utilize food diaries to assess the type and quantity of food people consumed. In general, our measurement of food insecurity may not be

sensitive to fluctuations in dietary intake and food availability thought the entire lockdown period. For example, later in the lockdown, efforts to supply residents by government and community member-led efforts may have improved the availability of fresh food. In general, the exposures assessed during the Shanghai lockdown period were time-varying and dynamic and therefore the association between the exposures and outcomes may have changed. To mitigate this potential source of bias, we adjusted for the date of survey participation in the analyses.

Despite these limitations, this is the only known study to assess the mental health and wellbeing of Shanghai residents during the largest lockdown of its kind in the world. The analyses adjusted for previous mental health diagnosis and past suicide attempt, which along with the adjustment of key covariates, provide strong evidence of the association between the exposures and outcomes in this current study.

The study further provides key insights for informing public health policy planning for infectious disease control and points to several areas of for improvements in public health policy. First, food insecurity emerged as a key exposure that yielded the highest association with mental disorders of any other exposure measured. With the rising threat of food insecurity, this is a timely study that demonstrates the potential impact of food insecurity on population mental health, which may generalize to other populations globally. Food systems and logistics should be strengthened to maintain access to adequate food during public health emergencies. Second, rapid survey analysis and digital surveillance can provide an important tool for monitoring the impact and informing real time policy changes during public health crises. In future pandemics, advances in digital technology can aid in real-time mental health surveillance efforts to coordinate intervention to those identified as most in need (Abbott, 2021). Third, in future pandemic and public health emergencies, the mental health of the population must be considered as central to emergency planning. Several studies have now documented the increased mental health burden associated with strict lockdown measures (Chu et al., 2020; Aknin et al., 2022; Gan et al., 2022; Guo et al., 2020); protecting public mental health needs to become a key priority alongside infectious disease control during the next public health emergency. Fourth, the health and wellbeing among the most vulnerable in society must be ensured. Vulnerability among youth, those with lower socioeconomic status, and migrant workers, as was the case in this study, provides insights to planning and preparedness that will ensure an adequate response for the entire population, that leaves no one behind.

## 5. Conclusions

During the 2022 Lockdown in Shanghai, 26.1 % and 20.1 % of people reported clinically significant symptoms of depression or anxiety, and 3.8 % reported suicidal ideation. This is substantially higher than previously observed prevalence estimates in Shanghai. Prevalences were higher among vulnerable groups, including migrants, young adults, and those with unstable employment. Food insecurity was especially high; 66.4 % of households surveyed were moderately or severely food insecure during the lockdown. Public health preparedness must include food systems strengthening and planned outreach to vulnerable populations to protect the wellbeing of residents during future lockdowns should they be deemed necessary.

## Data statement

Data is available from the first author based on reasonable request.

## Ethnical approval

Granted by the NYU Shanghai Institutional Review Board.

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## CRediT authorship contribution statement

**Brian J. Hall**: Conceptualization, Methodology, Software, Data curation, Supervision, Writing - Original draft preparation. **Gen Li**: Data curation, Validation, Writing - Reviewing and Editing. **Wen Chen**: Writing - Reviewing and Editing. **Donna Shelley**: Writing -Reviewing and Editing. **Weiming Tang**: Conceptualization, Methodology, Writing - Reviewing and Editing.

## Conflict of interest

The authors report no conflicts of interest.

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